

Production, practices and attitudes of beekeepers in Croatia

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ABSTRACT

We conducted a survey on the beekeeping production, practices and attitudes of 117 beekeepers in Croatia, via a questionnaire. The beekeepers were divided into three groups: full-time (professionals), part-time (side-liners) and hobby (hobbyists) beekeepers. The questions covered the purpose and size of their beekeeping production, the production interests of the beekeepers, treatment of the economically most important honeybee diseases, and the possibilities of the growth of their operation. Professional beekeepers were the youngest (39 years of age on average), with the largest average number of beehives *per* beekeeper (135 beehives), the largest proportion of LR hives and migratory apiaries, and the largest yearly *per* hive production of 17.04 kg of honey. The results show that the most marketable beekeeping product was honey, and that professional beekeepers also value propolis as equally interesting for production. They all inherited their beekeeping operations from their predecessors. Varroosis is perceived as the largest cause of honeybee colony death, followed by bad beekeeping practices. About 56% of the beekeepers are prepared to switch to organic/ecological beekeeping. Almost all the beekeepers (96.46%) support the introduction of the early diagnostics of American foulbrood. We found that professional beekeepers prefer the conservative economic model of growth based on their own equity, while hobbyists prefer a more expansive but riskier model of growth based on financial leverage (debt). Professional beekeepers are not inclined to create a mutual beekeepers' fund to cover losses. On the other hand, they strongly support the idea of creating an alliance for the purpose of joint market penetration.

Key words: beekeeping economics; honey production; treatment of honeybee diseases; organic beekeeping, Croatia

Introduction

Beekeeping is an important agricultural activity in many countries. It has a number of advantages. It serves as a source of employment,

income and a healthy outdoor lifestyle. Beekeeping in Croatia also has considerable economic importance. In the apicultural industry

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within the European Union high heterogeneity has been documented, and the only common characteristic is a high proportion of non-professional beekeepers and small average number of colonies *per* apiary (CHAUZAT et al, 2013). The total value of all beekeeping products is exceeded many times by the value and importance of plant pollination delivered by honeybees (ANONYM., 2016).

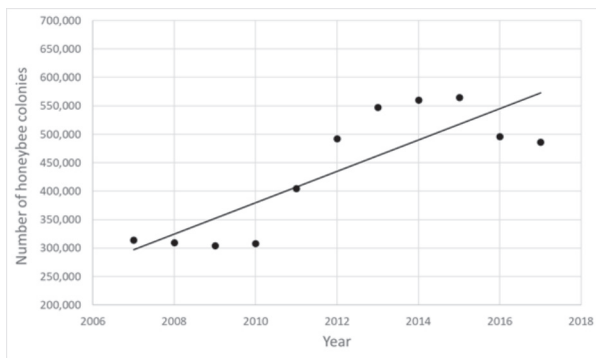


Fig. 1. Number of honeybee colonies in Croatia from 2007-2017 (FAO, 2019); (linear trend, correlation $r = 0.838$, $P = 0.013$)

Since 2007 beekeeping production in Croatia has shown significant growth (FAO, 2019). The number of honeybee colonies has increased at the average annual rate of 4.47% (Fig. 1) and honey production has increased even more, at the rate of 12.81% on average (Fig. 2).

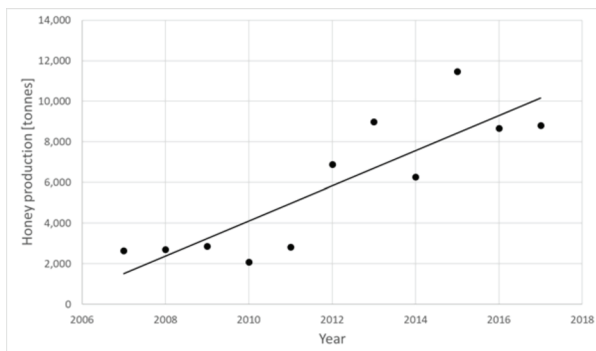


Fig. 2. Honey production in Croatia from 2007-2017 (FAO, 2019); (linear trend, correlation $r = 0.857$, $P = 0.0008$)

A large part of this growth occurred during the economic crisis in Croatia (2009-2014) (FAO, 2019). This makes the beekeeping sector

an excellent corrective in times of declining economic activity, contributing to the stability of the economy in general. Despite of such very positive trends, Croatia's natural production capacities are still poorly utilized. About 50% of domestic food consumption comes from imports, while at the same time people are leaving the country in search for employment. Every sign of the opposite trend should be strongly supported. However, any support, regardless of its origin (national, local government or EU funds), is a speculative experiment with an unpredictable outcome without good knowledge and understanding of the dynamics of beekeeping development. Understanding beekeepers' production, practices and attitudes is fundamental to encouraging newcomers into this branch of agricultural production. It is necessary to provide stakeholders and veterinarians with basic knowledge, hands-on skills and insight into beekeeping practices (IATRIDOU et al., 2019) that are as accurate as possible for making well-founded decisions.

In 2017 we conducted a detailed survey in which 117 beekeepers were asked to fill in a questionnaire and provide data about their production, practices and attitudes. The beekeepers were divided into three groups: full-time (professionals), part-time (side-liners) and hobby (hobbyists) beekeepers.

Materials and methods

This research is based on the data collected through the questionnaire. We collected 117 properly completed questionnaires with the beekeepers' answers to 25 questions. The data were analyzed using statistical methods in Excel, presented in the form of tables and figures. The questions can be divided into three main groups: the production, practices and attitudes of the beekeepers.

Results

Beekeeping production. The results regarding the beekeepers' production are presented in Table 1.

Out of 117 surveyed beekeepers 5 (4.27%) were professionals (full-time beekeepers), 51 (43.59%) were side-line (part-time) beekeepers and 61 (52.14%) were hobbyists, representing a total

Table 1. Beekeepers' production, from the sample

Beekeepers' production		Full-time beekeepers	Part-time beekeepers	Hobbyists	Sample	
1.	Number of beekeepers	5	51	61	117	
2.	Proportion of beekeepers (%)	4.27	43.59	52.14	100.00	
3.	Proportion of apiaries (%)	5.74	43.44	50.82	100.00	
4.	Proportion of migratory apiaries (%)	57.14	26.42	6.45	18.03	
5.	Average number of apiaries <i>per</i> beekeeper	1.40	1.04	1.02	1.04	
6.	Proportion of beehives (%)	17.90	52.77	29.33	100.00	
7.	Proportion of LR hives (%)	94.07	78.34	77.67	80.96	
8.	Average number of beehives <i>per</i> beekeeper	135	39	18	32	
9.	Proportion of honey production in the sample (%)	20.85	52.60	26.55	100.00	
10.	Proportion of honey production / proportion of beekeepers	4.88	1.21	0.51	1.00	
11.	Honey production (kg)	11,500	29,005	14,639	55,144	
12.	Number of beehives	675	1,990	1,106	3,771	
13.	Average honey production <i>per</i> beehive (kg)	17.04	14.58	13.24	14.69	
14.	Number of beekeepers	5	51	61	117	
15.	Average honey production <i>per</i> beekeeper (kg)	2,300	569	240	471	
16.	Honey sales (kg)	11,150	25,125	11,835	48,110	
17.	Proportion of honey sales in honey production (%)	96.96	86.62	80.85	87.24	
18.	Honey not sold <i>per</i> beekeeper (kg)	70.00	76.08	45.97	60.12	
19.	Average number of beehives <i>per</i> beekeeper	135	39	18	32	
20.	Proportion of beekeepers who inherited their beekeeping operation (%)	100.00	42.86	58.33	51.85	
21.	Average age of beekeepers (years)	39.00	43.91	47.16	45.37	
22.	Hierarchy of interests for production of apian products (%)	1.	honey and propolis (100%)	honey (96%)	honey (98%)	honey (97.44%)
		2.	pollen (80%)	propolis (49%)	propolis (40%)	propolis (46.15%)
		3.	queens, package bees, royal jelly (60%)	pollen (35%)	pollen (25%)	pollen (31.62%)
		4.	beeswax (40%)	beeswax (31.37%)	beeswax (21.31%)	beeswax (26.59%)

of 122 apiaries (100 stationary (81.97%) and 22 migratory (18.03%)). Of those, only 5 beekeepers (4.27%) had a stationary as well as a migratory apiary, while 95 (81.20%) and 17 (14.53%) of

them had exclusively either stationary or migratory apiaries, respectively. Full-time beekeepers had 7 (5.74%) apiaries (1.4 apiaries *per* beekeeper, 42.86% stationary and 57.14% migratory apiaries),

side-liners had 53 (43.44%) apiaries (1.04 apiaries *per* beekeeper, 73.58% stationary and 26.42% migratory), and hobbyists had 62 (50.82%) apiaries (93.55% stationary and 6.45% migratory).

A total of 3771 honeybee colonies were counted in the sample. Most of them (80.96%) were housed in LR (Langstrot Root) type of hives, followed by other hives (mostly the skeps), AŽ (Alberti-Žnidaršič) and DB (Dadant Blatt) representing 10.00%, 8.75% and 0.29%, respectively. The percentage of professional beekeepers using LR hives is higher than the other two groups of beekeepers and amounts to 94.07%. Beekeepers from the total sample had 32 hives on average. Every professional had on average 135 hives, every side-liner 39 hives and every hobbyist 18 hives on average. All the professional beekeepers together, although they were least represented (4.27%), had 17.90% of the hives from the sample, with which they produced 20.85% of honey from the sample, with an average annual production of 17.04 kg of honey *per* beehive, which is almost 27% more than the hobbyists, who produced 13.24 kg *per* hive on average. Side-liners produced 14.58 kg, which was almost 9% more than the hobbyists. In the sample as a whole, yearly *per* beehive production was almost identical to that of the side-liners, which was 14.69 kg. The honey production of the whole sample is 55,144 kg, out of which 48,110 kg was sold (87.24% of production). The average production of the professional beekeepers *per* beekeeper was 2,300 kg, of the side-liners 570 kg, and of the hobbyists almost 240 kg. In the sample as the whole the average production *per* beekeeper was slightly more than 470 kg. Professional beekeepers sold almost 97% of the honey they extracted, side-liners almost 87%, and hobbyists a little more than 83%. The amount of honey not sold (that beekeepers kept for themselves) by professionals was 70 kg (3.04% *per* hive), by side-liners 76 kg (13.38% *per* hive) and by the hobbyists around 45 kg (19.15% *per* hive). In the whole sample almost 13% of honey was not sold.

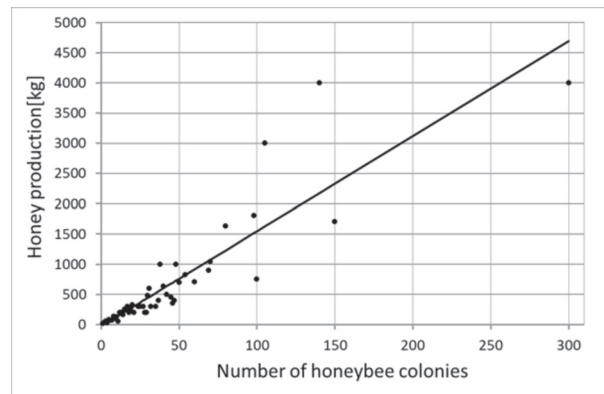


Fig. 3. The relationship between the number of honeybee colonies and honey production in Croatia from 2007-2017 (FAO, 2019).

The relation of honey production by the number of beehives is shown in Fig. 3, where a linear correlation was found ($r = 0.98$; $P = 3 \cdot 10^{-18}$). The results of the fitting procedure gave the following parameter values: $a = (16 \pm 1)$ kg/hive and $b = (-27 \pm 75)$ kg. The meaning of a is the quantity of honey produced *per* hive (16 kg/hive) *i.e.* the productivity of the honeybee colony situated in that hive.

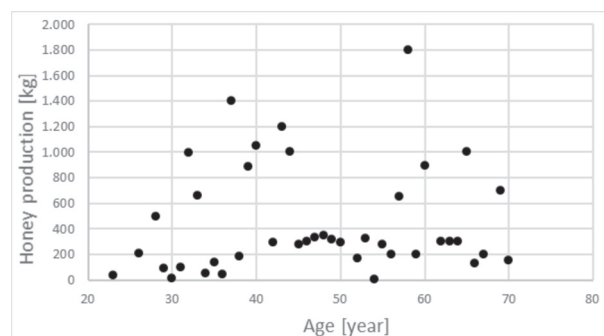


Fig. 4. The relationship between beekeepers' age and honey production.

Beekeeping activity was inherited by 51.85% of beekeepers, while 48.15% started their beekeeping on their own. The percentage of successors is the largest for professional beekeepers (100%), followed by side-liners (42.86%) and hobbyists (58.33%). Regarding the beekeepers' ages, the average in the sample was 45.37 years (an average of 39 years old for professionals, 43.91 for side-liners and 47.16 for hobbyists). The relationship between the beekeepers' age and honey production is presented in Fig. 4. Data analysis showed that there is no correlation between honey production and the beekeepers' ages ($r = 0.08$; $P = 0.71$).

Table 2. Beekeepers' practices, from the sample

Beekeepers' practices		Full-time beekeepers	Part-time beekeepers	Hobbyists	Sample	
1.	Proportion of beekeepers who use biological ways in combating Varroosis and other honeybee diseases (%)	75.00	85.71	78.00	81.55	
2.	Proportion of beekeepers who rear queens for themselves (%)	100.00	62.75	63.93	64.96	
3.	Proportion of beekeepers who purchase queens from other breeders (%)	40.00	39.22	36.07	37.61	
4.	Proportion of beekeepers who requeen their honeybee colonies (%)	every 2 nd year	100.00	80.39	54.10	67.52
		every year	20.00	7.84	8.20	8.55
		do not requeen	0.00	11.76	27.87	19.66
5.	Proportion of beekeepers who supplementary feed honeybee colonies in late summer (%)	100.00	93.75	84.21	89.10	
6.	Proportion of beekeepers who supplementary feed honeybee colonies with sugar syrup only (%)	60.00	50.00	33.33	41.82	
7.	Average quantity of sugar syrup <i>per</i> honeybee colony (l)	3.50	3.86	3.41	3.67	
8.	Proportion of beekeepers who supplementary feed honeybee colonies with sugar patties only (%)	20.00	18.75	28.07	23.64	
9.	Average quantity of sugar patty <i>per</i> honeybee colony (kg)	2.00	2.19	1.32	1.84	
10.	Proportion of beekeepers who supplementary feed honeybee colonies with sugar syrup and sugar patties (%)	20.00	25.00	22.81	23.64	
11.	Proportion of beehives in which adult bees dwindling was noticed (%)	0.74	2.41	5.15	2.75	
12.	Proportion of beehives with capped brood present where adult bees dwindled (%)	0.44	1.21	1.36	50.00	
13.	Proportion of beekeepers who treat honeybee colonies against Varroosis in fall-winter season (%)	60.00	86.27	72.13	77.78	
14.	The 3 most frequently used acaricides in fall-winter treatment against Varroosis with proportion of beekeepers who use that acaricide (%)	1.	oxalic acid (100.00)	oxalic acid (74.36)	oxalic acid (65.00)	oxalic acid (70.37)
		2.		Checkmite (7.69)	Checkmite (12.50)	Checkmite (9.88)
		3.		Varidol (5.13)	Varidol (7.5)	Varidol (6.17)
15.	Proportion of beekeepers who treat honeybee colonies against Varroosis in active beekeeping season (March to September) (%)	60.00	74.51	78.69	76.07	

Table 2. Beekeepers' practices, from the sample (continued)

Beekeepers' practices			Full-time beekeepers	Part-time beekeepers	Hobbyists	Sample
16.	The 3 most frequently used acaricides for treating Varroosis in active season (March to September) with proportion of beekeepers who use that acaricide (%)	1.	Checkmite, Bayvarol (40.00)	Checkmite (45.24)	Checkmite (37.74)	Checkmite (41.00)
		2.	Varidol (20.00)	Bayvarol (11.90)	Bayvarol (11.32)	Bayvarol (13.00)
		3.		formic acid, Varidol, Beevital (7.14)	formic acid (7.55)	formic acid, Varidol (7.00)
17.	The 3 months in which beekeepers treat honeybee colonies against Varroosis most frequently in active season with the proportion of beekeepers who do the treatment then (%)	1.	July (60.00)	July (51.28)	July (51.85)	July (52.04)
		2.	August (40.00)	August (20.51)	August (29.63)	August (26.53)
		3.		September (10.26)	September (9.26)	September (9.18)
18.	Average number of treatments <i>per</i> honeybee colony against Varroosis in active beekeeping season	1.3	1.43	1.17	1.29	
19.	Proportion of beekeepers who monitor daily <i>V. destructor</i> mite fall	80.00	83.33	69.39	76.47	
20.	3 most frequent measures beekeepers use in combating Nosemosis with proportion of these measures in %	1.	hygienic water supply (42.86)	hygienic water supply (50.67)	hygienic water supply (55.41)	hygienic water supply (52.56)
		2.	Iodine disinfectants, disinfection of the beeswax comb with acetic acid, supplementary feeding (14.29)	supplementary feeding (17.33)	iodine disinfectants (13.51)	supplementary feeding (14.10)
		3.		disinfection of the beeswax comb with acetic acid (13.33)	supplementary feeding (10.81)	iodine disinfectants (11.54)
21.	3 most frequent beekeepers' responses if they would find American foulbrood in their apiary with their proportion in %	1.	burn the suspicious beehive (60.00)	contact a veterinarian (57.14)	contact a veterinarian (54.97)	contact a veterinarian (55.24)
		2.	contact a veterinarian (40.00)	burn the suspicious beehive (36.73)	burn the suspicious beehive (29.41)	burn the suspicious beehive (34.29)
		3.		do not recognize the signs of disease (6.12)	do not recognize the signs of disease (9.80)	do not recognize the signs of disease (7.62)

Table 2. Beekeepers' practices, from the sample (continued)

Beekeepers' practices			Full-time beekeepers	Part-time beekeepers	Hobbyists	Sample
22.	3 most frequent causes of honeybee colony loss with their proportion in %	1.	Varroosis (27.27)	Varroosis (25.49)	Varroosis (28.30)	Varroosis (26.72)
		2.	all the other causes (9.09)	bad beekeeping practice (23.53)	poor or old queen, bad beekeeping practice (15.09)	bad beekeeping practice (18.10)
		3.		poor or old queen (19.61)		poor or old queen (16.38)

When asked about bee products, 97.44% of the beekeepers revealed a predominant interest in honey production. This was followed by interest in use of propolis (46.15%), pollen (31.62%), beeswax (26.50%), royal jelly (12.82%), honeybee queens (9.40%), adult honeybee packages (8.55%), and honeybee venom (5.13%). All the professionals were interested in producing honey and propolis, while 80% of them revealed an interest in pollen collection, 60% in the production of honeybee queens, honeybee packages and royal jelly, and only 40% showed an interest in beeswax production.

Beekeeping practices. The answers regarding beekeeping practices are summarized in Table 2.

Biological methods for combating varroosis and other economically important honeybee diseases were used by 75% of the professional beekeepers, by almost 86% of the side-liners and by 78% of the hobbyists. This amounts to 81.55% in the sample as a whole.

Almost 65% of beekeepers in the sample rear their own honeybee queens, while 38% purchase them from other queen breeders. There were 3 beekeepers who, although they rear their own honeybee queens, revealed that they resort to other queen breeders if necessary. All the professional beekeepers revealed that they rear their own honeybee queens, however 40% of them also purchase queens from other breeders.

Most of the beekeepers (67.52%) requeen their honeybee colonies every second year. Only 8.55% of them requeen their honeybee colonies

every year, and almost 20% do not requeen their honeybee colonies at all. All professionals requeen their honeybee colonies every second year, but 20% of them also occasionally do so every year. About 28% of hobbyists and 12% of side-liners do not requeen their honeybee colonies.

Supplementary feeding in late summer was not used by 12 beekeepers (about 16% hobbyists, 6% side-liners, and no professionals). There were 46 of them (41.82%) who supplementary feed their honeybee colonies with only sugar syrup, 26 (23.64%) with sugar syrup and sugar patties, and 26 (23.64%) with only sugar patties. The average amount of sugar syrup *per* beehive was 3.67 l (3.50 l used by professionals, 3.86 l by side-liners and 3.41 l by hobbyists) and the average weight of sugar patties used *per* honeybee colony was 1.84 kg (2.00 kg by professionals, 2.19 kg by side-liners and 1.32 among hobbyists). 80% of professionals supplementary fed their colonies with sugar syrup and 40% with sugar patties.

Dwindling of the number of adult honeybees had been noticed by 31 (26.50%) beekeepers in 104 hives, 2.75% of all beehives in the sample. The professionals noticed dwindling in 0.74% of beehives, side-liners in 2.41% of beehives, and hobbyists in 5.15% of beehives. In 50% of beehives in which dwindling was noticed (52 out of 104) the beekeepers found a sealed brood.

A total of 91 out of 117 beekeepers (77.78%) revealed that they treat their colonies against varroosis in the fall-winter season. They

Table 3. Beekeepers' attitudes, from the sample

Beekeepers' attitudes		Full-time beekeepers	Part-time beekeepers	Hobbyists	Sample
1.	Proportion of beekeepers who support forming an alliance for the purpose of joint market penetration (%)	75.00	57.45	54.72	56.73
2.	Proportion of beekeepers who expressed the need for a loan (%)	0.00	37.78	34.78	34.74
3.	Average amount of the funds needed for those who specified that amount (in €)	0	6,700	13,400	10,000
4.	Average age of beekeepers who specified the amount of funds needed (years)	0	39.5	56	45
5.	Proportion of beekeepers who support the idea to establish a fund for help in case of losses (%)	50.00	83.72	78.85	79.80
6.	Proportion of beekeepers who are ready to do the ecological (organic) beekeeping (%)	50.00	55.32	57.69	56.31
7.	Proportion of beekeepers who support the introduction of early diagnostics of American foulbrood (%)	80.00	98.00	96.55	96.46

predominantly use oxalic acid (70.37% beekeepers who treated their honeybee colonies), followed by veterinary medical products (VMP) Checkmite and VMP Varidol (10% and 6% of cases, respectively), as well as formic acid (2.5% of cases). 60% of the professionals treated their honeybee colonies exclusively using oxalic acid. Other acaricides such as: timol (VMP Apigard), formic acid, amitraz and rotenone were used in less than 3% of cases in the whole sample.

During the active beekeeping season, from March to September, beekeepers treat every honeybee colony against Varroosis 1.29 times on average. For that, beekeepers mostly use VMP Checkmite (in 41% of cases), VMP Bayvarol in 13%, and VMP Varidol and formic acid in 7% of cases each. Professional beekeepers mostly use authorized and registered VMPs: Checkmite and Bayvarol (in 40% of cases each), and Varidol in 20% of cases. Likewise, 40% of professional beekeepers revealed that they do not treat their colonies during the active beekeeping season. In the sample as a whole, almost 24% of beekeepers did not treat varroosis during the season examined.

In the active beekeeping season the control of varroa mites was mostly conducted in July (52.04%), then in August (26.53%) and September (about 9%). Professional beekeepers treated

Varroosis mostly in July (60%) and August (40%), but not in September.

Most beekeepers, 76.47% of them, monitored the daily drop of *Varroa destructor* mites onto the hive bottom board during the active season, that is 80% of professionals, 83.33% of side-liners and 69.39% of the hobbyists .

In terms of preventive and control measures, beekeepers used means to combat Nosemosis, where the most frequently used was a hygienic water supply (52.56%), followed by supplementary feeding preparations (14.10%), iodine disinfectants (11.54%) and comb disinfection with acetic acid (10.26%). The professionals mostly used hygienic water supply (42.86%), and iodine disinfectants, comb disinfection with acidic acid and supplementary feeding preparations each in the same percentage (14.29%).

If beekeepers found characteristic clinical symptoms of American foulbrood of honeybees in colonies in their apiaries, most of them (55.24%) would contact a veterinarian, 34.29% would burn the suspicious beehives, but 7.62% declared they would not be able to recognize the signs of the disease. Only 1.90% would treat the ailment with antibiotics, and 0.93% would shake off the adult bees into a new hive. 60% of professionals would burn the beehives and 40% would contact an official veterinarian.

As the three most common causes of honeybee colony losses, the beekeepers indicated Varroosis (26.72%), bad beekeeping practices (18.10%) and low-quality honeybee queens (16.38%). The professionals gave the order as follows: Varroosis (27.27%), followed by all the other causes (9.09% each).

Beekeepers' attitudes. The attitudes of the beekeepers are presented in Table 3. Almost 68% of the beekeepers supported the idea of creating an alliance for the purpose of joint market penetration. 75% of the professionals supported this idea, 57.45% of the side-liners and 54.72% of the hobbyists.

The need for a loan was expressed by 34.74% of beekeepers (37.78% side-liners, 34.78% hobbyists and none of the professionals). Out of those who were in favor of taking loans only 4 (12.12%) specified the amount needed, which was 10,000 € on average. From those, two beekeepers were hobbyists and asked for 26,700 € (one 20,000 € and the other 6,700 €), and the other two were side-liners who wanted to raise 6,700 € each. All these four were in the middle-aged category (30-49 years of age).

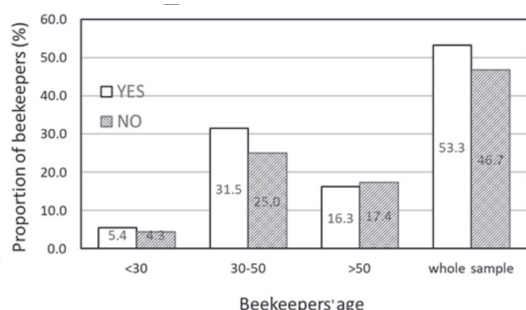


Fig. 5. The proportion of beekeepers interested in switching to organic beekeeping, by age (%)

The establishment of a fund for help in cases of loss and/or natural disasters was supported by 79.80% of the beekeepers in the sample, namely 50% professionals, 83.72% side-line beekeepers and 78.85% hobbyists.

The readiness to switch to ecological (organic) beekeeping mode was expressed by 56.31% of the beekeepers, 50% of professionals, 55.32% of side-liners and 57.69% of hobbyists. Fig. 5 shows the proportion of beekeepers ready to switch to organic beekeeping by age.

The introduction of early routine diagnostics of American foulbrood was supported by 96.46% of the beekeepers in the sample, of which 80% were professionals, 98% side-line beekeepers and 96.55% hobbyists.

Discussion

The data analysis in the survey was based on the assumption that the more experienced beekeepers were, the more opportunities to improve their operation they had; and because of their greater experience, *i.e.* faster learning from their own mistakes, they succeeded in improving or maintaining the efficiency of their production. According to this rationale, the beekeepers were divided into three groups. The first group consists of full-time or professional beekeepers, for whom beekeeping is their largest source of financial income. The average number of beehives *per* professional in this survey was 135. The proportion of professionals in the sample was 4.27% (5 of 117). In the group of part-time (side-line) beekeepers, who keep bees as a supplementary source of income, the average number of beehives *per* beekeeper was 39, and their proportion in the sample was 43.59% (51 of 117), which is similar to previously published data (SVEČNJAK et al., 2008). Hobby beekeepers had on average 18 hives, representing 52.14% (61 of 117) of the sample. According to the National Beekeeping Program (ANONYM., 2019) the structure of beekeepers is as follows: 41.52% (1-30 beehives), 54.81% (31-50 beehives) and 3.67% (> 150 beehives). Our data showed the pyramidal structure of the sample, where the hobbyists form the wide base of the pyramid (Fig. 6).

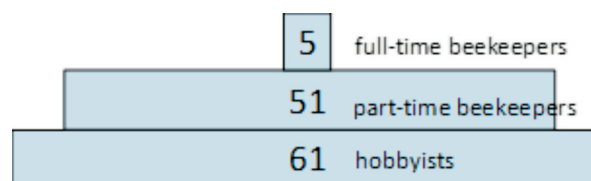


Fig. 6. Pyramidal structure of the sample, in relation to the beekeepers' level of engagement (employment status)

If the quantity of beekeeping experience is presented through the number of beehives, *i.e.* the colonies which the beekeeper takes care of,

it may be concluded that one professional in one beekeeping season could acquire 7.5-fold more experience, *i.e.* practice, than a hobbyist, and about 3.5-fold more practice than a side-line beekeeper. Looking at these numbers, from the perspective of an old German proverb “Übung macht den Meister” (“Practice makes perfect”), the production results, practices and attitudes of the beekeepers from the three aforementioned groups becomes clearer.

Honey is considered the most marketable bee product (DENŽIĆ LUGOMER et al., 2019) which makes the honey production *per* beehive an important indicator of beekeeping production success. The professional beekeepers had an average yearly *per* beehive production of 17.04 kg, side-liners 14.58 kg, the hobbyists 13.24 kg, and the whole sample 14.69 kg. Accordingly, one professional beekeeper produced 2.300 kg of honey on average, one side-liner 569 kg and one hobbyist 240 kg. Congruously to CVITKOVIĆ et al. (2009), the honey production increased by 2.14% annually, and a trend analysis of the variable predicted with 95% certainty that *per* beehive production in Croatia in 2015 would be somewhere between 16.34 and 20.87 kg. According to results of this study, professional beekeepers have fulfilled this prediction.

The age of the average professional was 39 years, the youngest of all groups. He had 1.4 apiaries, in which the proportion of LR hives, which are considered the most suitable for high production, was 94.07%. On average, professionals sold 96.96% of the honey they extracted, and kept 70 kg for themselves. The average side-line beekeeper was almost 44 years of age (43.91), had 1.039 apiaries in which the proportion of LR hives was 78.34%, and sold 86.62% of the honey produced (*i.e.* kept 76.08 kg for himself). An average hobbyist was 47.16 years old, had 1.016 apiaries, with a proportion of LR hives of 77.67%, sold 80.85% of the honey produced, and kept 45.97 kg of honey for his own needs.

All the professionals were mostly interested in the production of honey (CVITKOVIĆ, 2007), and propolis for its medical properties (TLAK GAJGER et al., 2017a), as well as for pollen grain collection (80%), often used for preparation

of food additive mixes. 60% of professional beekeepers declared an interest in honeybee queen production, which was not surprising due to the need for frequent requeening as a consequence of the negative impacts from the environment, *i.e.* pesticides (TLAK GAJGER et al., 2017b), mobile phone radiofrequencies (VILIĆ et al., 2017; TLAK GAJGER et al., 2019b) or bad beekeeping practices in disease control (TLAK GAJGER et al., 2013; TLAK GAJGER and SUŠEC, 2019.).

From the same group, 40% of beekeepers reported their interest in beeswax production, probably because they wanted to use their own high-quality beeswax during the processing and production of wax foundations, with the aim of avoiding possible adulteration (SVEČNJAK et al., 2015) and “wash out” of the various xenobiotics from pure beeswax material during the safe recycling process (TLAK GAJGER et al., 2016; KOSANOVIĆ et al., 2019). Side-liners were a little less interested in honey production (96%), considerably less interested in propolis production (49%), pollen grain collection (35%) and beeswax production (31.37%). The results from hobbyists followed the same pattern. They showed the largest interest in honey production (98%), and were considerably less interested in propolis use (40%), pollen collection (25%) and beeswax production (21.31%).

All the professional beekeepers produce honeybee queens themselves, while a considerably lower proportion of side-liners and hobbyists do so (63%). All professionals requeen their honeybee colonies every second year (sometimes every year), while the the proportion of those who do not requeen their honeybee colonies increases from side-liners (11.76%) to hobbyists (27.87%). In all groups the majority of beekeepers requeen their honeybee colonies every second year.

Supplementary feeding of honeybee colonies in the late summer was applied by all professionals, a little less by side-liners (93.75%) and even less by hobbyists (84.21%). Sugar syrup was more frequently used than sugar patties (80% of professionals, 75% of side-liners and 56.14% of hobbyists), while hobbyists used sugar patties relatively more frequently than others (50.88%).

The annual average quantity of sugar syrup used *per* beehive was around 3.5 L in all groups, while an average quantity of sugar patties was 2 kg *per* beehive, with somewhat larger deviation in hobbyists, with 1.32 kg.

Dwindling of the number of adult bees was noticed in only 0.74% beehives of the professionals, in 2.41% beehives of the side-liners, and hobbyists had the highest percentage of beehives (5.15%) where the number of adult bees had dwindled.

The fall-winter treatment of honeybee colonies against Varroosis was applied by most of the beekeepers, but this percentage was lowest for professionals (60%), probably because they applied regular and successful summer treatment using authorized VMPs (TOMLJANOVIĆ et al., 2012), which is a legal obligation of beekeepers (ANONYM., 2019a). Beekeepers from all three groups used oxalic acid most as most frequent treatment against *V. destructor* mites (all the professionals and about 70% of beekeepers in the sample as a whole). The second most frequently used preparation was Checkmite at 9.88%, and the third was Varidol at 6.17%. For this treatment, the professionals exclusively used oxalic acid. The predominant acaricide used during winter was organic oxalic acid, which may be explained by the fact that before 2017 there was no VMP registered for use in *V. destructor* mite number control in Croatia (TLAK GAJGER and SUŠEC, 2019), but VMP Varidol was authorized in some other countries, and could be used for the cascade system (ANONYM., 2019b). The use of other acaricides during the winter could be ascribed to bad beekeeping practices, as well as using “home-made” preparations, mostly by mixing various unauthorized ingredients, in general.

In the active beekeeping season (from March through September) the indicators were very similar to those in the fall-winter season. In the whole sample 76.07% of beekeepers treated their honeybee colonies. The acaricides used most in sample were Checkmite (41%), Bayvarol (13%), Varidol and formic acid (7% each). From this pattern, only professionals differed significantly in that they used Bayvarol as often as Checkmite (40%). This may be explained by the recommendation of good

veterinary and environmental practice to change the VMP (to one with different active ingredients) after a few seasons (TOMLJANOVIĆ et al., 2012; RITTER, 2014). The three months in this season when beekeepers treat honeybee colonies most frequently were July (52.04%), August (26.53%) and September (9.18%), which is in accordance with the national regulations (ANONYM., 2019a). Professional beekeepers were the only ones who did not treat their colonies in September. The average number of treatments *per* honeybee colony in the active season was 1.29.

The vast majority of beekeepers monitored the natural varroa mite drop on a daily basis, which amounts to 76.47%, with relatively small deviations in different groups.

The three measures predominantly used by beekeepers in prevention of Nosemosis, in the whole sample, were a hygienic water supply (52.56%), followed by preparations used in a significantly smaller proportion, such as supplementary feeding (14.10%) and iodine disinfectants (11.54%). Amongst these values, the largest discrepancy was found among the professionals, who used a hygienic water supply in a smaller percentage (42.86%).

The three most frequent reactions of beekeepers to the question about what they would do if they found American foulbrood in their apiary, were that they would contact a veterinarian (55.24%), burn down the suspicious beehives (34.29%) and not recognize the disease signs (7.62%). From these results, the most difference was found among the professionals who would all recognize the signs of the disease, 60% would burn down the infected hives, and 40% would contact a veterinarian.

As the three most frequent causes of honeybee colony losses, the beekeepers mentioned Varroosis (26.72%), bad beekeeping practices (18.10%), and a weak or old queen bee (16.38%). Professionals differed from this average because in the second place they specified all the other causes (except varroosis) in the same proportion, at 9.09%, each. The main reasons for honeybee colony collapse during the winter of 2008/2009, reported by beekeepers, were Varroosis (16.12%), Nosemosis (14.20) and queen loss (16.93%) (TLAK GAJGER

et al., 2010). Also, according to publications linked with massive honeybee losses, *Nosemosis* type C is often on top of the list (HIGES et al., 2008; VEJSNÆS et al., 2010).

The proportion of beekeepers who support the idea of creating an alliance for joint market penetration was 56.73%. However, among the professionals this proportion was much higher (75%) and this could be attributed to the major production surplus and the need to make sales easier.

The need for loans was expressed by 34.74% of beekeepers, but not by any of the professionals. The average amount of the funds needed was indicated by only 4 beekeepers, and it was 75,000 HRK (10,000 €). Among the side-liners this average was 50,000 HRK (6,700 €), and among the hobbyists 100,000 HRK (13,300 €). Therefore, we can conclude that the professional beekeepers prefer the conservative economic model of growth based on their own equity, while hobbyists prefer a more expansive and riskier model of growth, based on financial leverage (debt). The average age of the beekeepers who specified the amount of funds needed was 45 years (39.5 in the side-liners and 56 in the hobbyists).

The percentage of beekeepers who support the idea of creating a fund for help in cases of loss was 79.80%, where professionals supported this idea the least (50.00%) and the side-liners the most (83.72%). It seems that professionals were not so motivated to cover losses caused by the bad beekeeping practices of other, less experienced groups of beekeepers. Currently, the Ministry of Agriculture in Croatia covers losses due to damage caused by measures to treat clinically visible outbreaks of notifiable diseases (dead honeybee colonies, the pertaining contaminated hive and small beekeeper tools) with the aim of efficient disease eradication. The conditions for financial refunds include the obligation that beekeeping practices must in accordance and combination with other specific regulations prescribed by the national authorities (TLAK GAJGER, 2017). Introduction of early American foulbrood diagnostics was supported by the large majority of beekeepers (96.46%), but least by the professionals (80.00%).

Switching to ecological/organic beekeeping was supported by 56.31% of beekeepers in the sample: the least by professionals (50.00%) and the most by hobbyists (57.69%), probably because of their implementation of good beekeeping practices and the production of bee products which are food for humans, without risk in terms of safety and quality (BILANDŽIĆ et al., 2014, 2017; BILANDŽIĆ et al., 2018; BOTIAS et al., 2013; DENŽIĆ LUGOMER et al., 2019; MAISTRELLO et al. 2008; SEDAK et al. 2018).

Beekeeping operations were inherited by 51.85% respondents, all the professionals, and the least side-liners (42.86%).

On the basis of data from the Croatian Pension Insurance Institute and the Croatian Employment Service, Table 4 shows the number of employed and unemployed beekeepers in Croatia from 2016-2018 (HZMO, 2019; HZZ, 2019).

Table 4. The number of employed and unemployed beekeepers in Croatia from 2016-2018 (HZMO, 2019; HZZ, 2019)

Year/month	Employed beekeepers	Unemployed beekeepers
2016/06	25	11
2016/12	24	9
2017/06	23	7
2017/12	22	4
2018/06	24	6
2018/12	22	3

The number of employed beekeepers did not show any significant changes in range or direction, and was not subject to significant seasonal variations. Regardless of the small numbers of unemployed beekeepers, a downward trend is evident, which corresponds to the same trend in the overall unemployment at the national level.

Conclusions

The most marketable beekeeping product for the surveyed beekeepers is honey. Professional beekeepers also valued propolis as equally interesting in apian production. Professional beekeepers were the youngest (39 years of age on average), had the

largest average number of beehives *per* beekeeper (135 hives), the largest proportion of LR hives and migratory apiaries, and the highest annual honey production *per* beehive, of 17.04 kg of honey. They had all inherited their beekeeping operations from their predecessors. On average, they acquired 7.5-fold more beekeeping experience *per* season than an average hobbyist, and were not interested in taking loans to expand their operations. In that regard, it seems that this form of beekeeping should be strongly encouraged among the other groups of beekeepers and newcomers, especially those of a younger age. Varroosis was perceived as the largest cause of honeybee colony losses (in nearly 27% of cases) being followed by bad beekeeping

practices (mostly due to a lack of experience and knowledge). In the active beekeeping season (from March through September) the varroa mite population was predominantly controlled using VMP Checkmite in July. In the fall-winter season oxalic acid was used most. For Nosemosis control, a hygienic water supply was the most frequently used preventive measure. About 56% of beekeepers were prepared to switch to ecological/organic beekeeping. Almost all the beekeepers (96.46%) supported the introduction of the early diagnostics of American foulbrood.

As the demographics of the European beekeeping industry have been poorly described, this study represents a major contribution to its improvement.

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TOMLJANOVIĆ, Z., D. CVITKOVIĆ, S. PAŠIĆ, B. VOLAREVIĆ, I. TLAK GAJGER: Proizvodnja, praksa i stavovi pčelara u Hrvatskoj. Vet. arhiv 90, 413-427, 2020.

SAŽETAK

Upitnikom smo proveli istraživanje o pčelarskoj proizvodnji, praksi i stavovima 117 pčelara u Hrvatskoj. Pčelari su bili podijeljeni u tri skupine: profesionalci, pčelari iz dopunske djelatnosti i hobisti. Pitanja su obuhvatila svrhu i veličinu pčelarske proizvodnje, proizvodne interese pčelara, liječenje ekonomski najvažnijih bolesti pčela i mogućnosti za rast djelatnosti. Profesionalni pčelari bili su najmlađi (u prosjeku 39 godina), imali su najveći prosječan broj košnica po pčelaru (135 košnica), imali su najveći udio LR košnica i pokretnih pčelinjaka te su imali i najveću proizvodnju meda po košnici od 17,04 kg. Rezultati pokazuju da je najprodavaniji pčelarski proizvod med, dok profesionalni pčelari i propolis smatraju jednako zanimljivim za proizvodnju. Za razliku od drugih skupina, svi su pčelarstvo naslijedili od svojih predaka. Varooza se smatra najvećim uzrokom uginuća zajednica, a slijedi je loša pčelarska praksa. Oko 56 % pčelara spremno je prijeći na ekološko (organsko) pčelarstvo. Gotovo svi pčelari (96,46 %) podržavaju uvođenje rane dijagnostike američke gnjiloće pčelinjeg legla. Utvrdili smo da profesionalni pčelari preferiraju konzervativni ekonomski model rasta temeljen na vlastitom kapitalu, dok hobisti preferiraju ekspanzivniji, ali i rizičniji model rasta koji se temelji na financijskoj poluzi (dugu). Profesionalni pčelari nisu skloni stvaranju zajedničkoga pčelarskog fonda za pokrivanje gubitaka. S druge strane, snažno podupiru ideju udruživanja sa svrhom zajedničkog prodora na tržište.

Ključne riječi: ekonomika pčelarstva; proizvodnja meda; liječenje bolesti medonosne pčele; ekološko (organsko) pčelarstvo; Hrvatska
